

**IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF MASSACHUSETTS**

SINGULAR COMPUTING LLC,

Plaintiff,

v.

GOOGLE LLC,

Defendant.

C.A. No. 1:19-cv-12551-FDS

Hon. F. Dennis Saylor IV

**DEFENDANT GOOGLE LLC'S REPLY IN SUPPORT OF  
ITS MOTION FOR SUMMARY JUDGMENT OF NON-INFRINGEMENT**

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Defendant Google LLC (“Google”) respectfully submits this Reply in Support of its Motion for Summary Judgment of Non-infringement (“Motion”) responding to Plaintiff Singular Computing LLC’s (“Singular”) opposition thereto (“Opposition”). Dkt. 505 (“Opp.”).

## I. INTRODUCTION

Singular’s Opposition concedes the key predicates of Google’s Motion. Singular does not dispute that the “exceeds by at least one hundred” limitation is structural, and it admits that “[i]n order to meet the ‘exceeds by at least one hundred’ requirement of the Asserted Claims,” the accused Tensor Processing Unit (“TPU”) boards “need[] to include at least 8,300 LPHDR execution units” (“LPHDR EUs”). Opp. at 2 (internal quotations omitted). Singular also does not dispute that under the infringement theory of its technical expert, Dr. Sunil Khatri, each accused LPHDR EU in the TPU boards comprises two rounding circuits—indeed, Singular uses the same composite sketch from Dr. Khatri’s report that Google used to illustrate his theory. *Id.* at 3. Nor does Singular materially dispute the structure of the TPU boards or their componentry, including that there are only 2,048 such rounding circuits in the accused TPUv2 boards and only 4,096 rounding circuits in the accused TPUv3 boards. Dkt. 505-1 (“Pltf’s SMF”) at 2 (¶¶ 10, 17). The absence of any genuinely disputed material facts is perhaps most clearly reflected in Singular’s responsive statement of facts, which largely points to immaterial issues and cites almost no record evidence to contest the few facts it purports to dispute.<sup>1</sup> Ultimately, these

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<sup>1</sup> For example, Singular claims it does not understand “application-specific integrated circuit board,” even though Dr. Khatri used the nearly identical term “application-specific circuit boards” in his report. Pltf’s SMF at 1 (¶ 3); Narayan Decl., Ex. 1 (Dr. Khatri Rpt.) ¶ 71. Singular immaterially disputes another of Google’s asserted facts because it purportedly does not understand the word “large.” Pltf’s SMF at 2 (¶ 9). In any event, Singular cites no record evidence for most of its “disputes” with Google’s asserted facts, which should therefore be deemed admitted. *See* L.R. 56.1; *Landino v. Mass. Tchrs. Ass’n*, 621 F. Supp. 3d 185, 189 n.1 (D. Mass. 2022) (deeming facts admitted “because [plaintiff] did not provide supporting evidence” for purported disputes “as required by . . . L.R. 56.1”), *appeal filed*, No. 22-1691 (1st

admissions warrant summary judgment for Google because the undisputed structure of the accused TPU boards does not include the required number of LPHDR EUs, even as defined by Dr. Khatri.

To get around this problem, Singular’s Opposition posits a “unique pairs” argument that explicitly relies on counting each *physical* rounding circuit over and over and *over* again—128 times, to be exact—thereby inflating the purported number of LPHDR EUs in each TPU board by a factor of 128. Singular tries defending this argument, which Dr. Khatri did not articulate in his report, on the purported ground that “[t]he [Court’s claim construction order] does not suggest or require that the same circuitry cannot be shared by more than one LPHDR execution unit.” *Id.* at 4 (¶ SMF 12). But Singular’s “unique pairs” argument conflicts with the Court’s claim construction order, which construed “execution unit” as a “processing element comprising an arithmetic circuit paired with a memory circuit” and explained that a processing element must be a “tangible object.” Dkt. 354 at 24–25. Nor is double-counting—much less 128-counting, as Singular does—supported by the specification of the asserted patents, as Singular claims. Quite the opposite: when the specification shows arithmetic operators relying on “share[d] circuitry,” it illustrates them as a single unit, not two. *See, e.g.,* Seeve Decl., Ex. C (’156 patent) at 10:38–40, 12:53–13:3, and 13:42–46.<sup>2</sup>

Singular’s Opposition all but abandons the theory in Dr. Khatri’s report, which was based on the number of purported “LPHDR multiplication operations” performed by the TPU boards each clock cycle. *See* Narayan Decl., Ex. 1 (Dr. Khatri Rpt.) ¶ 224.<sup>3</sup> Indeed, Singular devotes

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Cir. Sept. 9, 2022).

<sup>2</sup> “Seeve Decl.” refers to the Declaration of Brian Seeve (Dkt. 505-2) filed in support of Singular’s Opposition.

<sup>3</sup> “Narayan Decl.” refers to the Declaration of Vishesh Narayan (Dkt. 463) previously filed in

most of its Opposition not to defending that theory, but to articulating its new “unique pairs” argument. Singular’s pivot confirms the flaws in its original theory, but the new theory fares no better, because it does not solve Singular’s core problem: it cannot identify the required minimum of 8,300 LPHDR EUs in each TPU board without double-counting (by a factor of 128) a key part of the purported LPDHR EUs.

Singular’s remaining arguments are designed to give the appearance of a bona fide dispute but are immaterial. Google’s Motion does not depend on any non-infringement opinions expressed by its own expert, Dr. Martin Walker, so Singular’s discussion and criticisms of Dr. Walker’s opinions are irrelevant strawmen. *See* Opp. at 8–9. So too for Dr. Miriam Leeser’s opinions about how her prior art “VFLOAT system” invalidates the Asserted Claims, which do not double-count the rounding and normalization circuits she identified, distinguishing her opinions from Singular’s improper theory.

## II. ARGUMENT

### A. Singular Has All But Abandoned The Infringement Opinion In Dr. Khatri’s Report, Which Relied On Counting Purported “LPHDR Multiplication Operations.”

As Google explained in its Motion, Dr. Khatri’s opinion that there are 131,072 LPHDR EUs in the TPuv2 board and 262,144 LPHDR EUs in the TPuv3 board is impermissibly based on the number of purported “LPHDR multiplication operations” (Dr. Khatri’s terminology) that the TPU boards perform each clock cycle when in operation. Mot. at 2–3, 13–15. Google’s explanation did not “ignore[] Dr. Khatri’s actual infringement positions” as Singular contends, nor did it “falsely” characterize them. Opp. at 10. To the contrary, Google directly quoted Dr. Khatri’s own report, *see* Mot. at 13–15, which identifies the number of “LPHDR multiplication

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support of Google’s Motion.

operations” performed each clock cycle as the basis for his counting to reach the number of LPHDR EUs required by the “exceeds by at least one hundred” limitation:

[REDACTED]

[REDACTED]

[REDACTED]

Narayan Decl., Ex. 1 (Dr. Khatri Rpt.) ¶¶ 224–225, 228, 233 (emphases added). Dr. Khatri’s report thus makes the purported number of “LPHDR multiplication operations” performed by the TPU boards each “clock cycle” *the* premise for this part of his infringement theory.

In a tacit concession that it cannot rely on the number of “complete[d]” *operations* to meet a *structural* claim limitation, Singular’s Opposition recasts this unambiguous language from Dr. Khatri’s report as merely confirming some other counting method used by Dr. Khatri and/or establishing a “lower bound” on the number of LPHDR EUs. Opp. at 11–12 & n.9. But there is no other counting methodology in Dr. Khatri’s report for how the “exceeds by at least one hundred” limitation is purportedly satisfied besides the paragraphs above, which tellingly never use the word “confirm” or “lower bound.”<sup>4</sup>

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<sup>4</sup> Indeed, Singular does not cite anything in Dr. Khatri’s report for its explanation of how the number of “LPHDR multiplication operations” performed by a TPU board purportedly provides a “lower bound” on the number of LPHDR EUs—because there is nothing in Dr. Khatri’s report to cite. See Opp. at 12 n.9.

In any event, Singular’s attempt to pivot away from Dr. Khatri’s stated “LPHDR multiplication operations” theory just confirms what Google argued in its Motion—that completed operations cannot provide the basis for infringing a structural limitation of an apparatus claim. Indeed, not only has Singular ignored all the authority Google cited in the Motion, *see* Mot. at 14–17, its reliance on *INVT SPE LLC v. Int’l Trade Comm’n*, 46 F.4th 1361 (Fed. Cir. 2022), proves Google’s point. *See* Opp. at 11. In *INVT SPE*, the Federal Circuit reiterated “the principle that ‘apparatus claims cover what a device *is*, not what a device *does*’” as a “useful reminder that the focus of apparatus claims is the structure and not the operation or use” of an accused product. *INVT*, 46 F.4th at 1376 (emphasis in original). But, the court also noted, “apparatus claims routinely depend on functional claiming to describe the apparatus,” and in that context, “what the device *does* (and how it does it) is highly relevant to understanding what the device *is*.” *Id.* at 1376–77 (emphasis in original). The court gave examples of such functional claiming: “a logical engine *for preventing* execution,” “a communications engine *for obtaining* a Downloadable,” and “a linking engine *for forming* a sandbox package.” *Id.* at 1373 (emphasis in original). But the “exceeds by at least one hundred” limitation is not recited in this fashion. Mot at 16–17. It does not, for example, claim “a plurality of execution units *for performing* at least 8,300 LPHDR multiplication operations per clock cycle” or anything similar. Singular cannot “modify the scope of its claim” post-hoc by substituting a functional requirement for a structural one. *Lutron Elecs. Co. v. Crestron Elecs., Inc.*, 970 F. Supp. 2d 1229, 1236 (D. Utah 2013).

**B. Dr. Khatri Has Not “Demonstrate[d] That the Accused TPUv2 and TPUv3 Devices Contain 131,072 / 262,144 LPHDR Execution Units.”**

Dr. Khatri’s report did not “demonstrate[] that the accused TPUv2 and TPUv3 devices contain 131,072 / 262,144 LPHDR execution units, respectively” as Singular claims. Opp. at 2.



Singular’s effort now to prove otherwise reveals that its “unique pairs of rounders” theory fundamentally rests on repeatedly counting the same sounding circuits 128 times to inflate the purported number of LPHDR EUs in the accused TPU boards above the required minimum of 8,300. As a threshold matter, this theory is absent from Dr. Khatri’s infringement report, despite it now being the linchpin of Singular’s Opposition. Dr. Khatri’s report never refers to LPHDR EUs that are made up of “unique pairs” of rounding circuits, nor does it even use the term “unique pair.” *See* Narayen Decl., Ex. 1 (Dr. Khatri Rpt.) ¶¶ 222–238. Given the failure to disclose this theory even in Dr. Khatri’s expert report, it should be disregarded. Fed. R. Civ. P. 26(a)(2)(B); *Clinicom Int’l, Inc. v. Cerner Corp.*, No. 17-cv-02479, 2023 WL 1767008, at \*9 (S.D. Cal. Feb. 3, 2023) (finding it “improper for [plaintiff] to attempt to introduce [a] new previously undisclosed theory of infringement at . . . summary judgment”).

But even if the Court were to consider Singular’s “unique pairs” theory, it is evident from Singular’s explanation of this theory in its Opposition that it is counting each rounding circuit over and over again, such that each physical rounding circuit is counted 128 times as part of 128 purportedly separate LPHDR EUs in order to meet the numerosity requirement of the “exceeds by at least one hundred” limitation. Indeed, Singular expressly admits that under this “unique pairs” theory, “each individual rounder is *shared*” across 128 purported LPHDR EUs. Opp. at 4–8 (emphasis added). Despite this admitted 128-counting of physical circuitry, Singular claims that the purported LPHDR EUs are “physically distinct.” *Id.* at 8. Not so. The purported LPHDR EUs are not “distinct” because Singular is just counting the same physical rounding circuits over and over again as part of different purported LPHDR EUs. Although Singular claims that “all of these 16,384 LPHDR execution units operate simultaneously,” *id.* at 4, this conclusion is belied by a simple fact that there are 256 rounding circuits in each VPU, *see*

Narayan Decl., Ex. 1 (Dr. Khatri Rpt.) ¶ 231. While there are 16,384 distinct multiplier circuits in each MXU, *see* Opp. at 4, the lack of 16,384 distinct corresponding rounding circuits dooms Singular’s contention that there are 16,384 distinct execution units. This is because each EU must, under Singular’s own theory, include a pair of rounding circuits in order to perform the rounding operation that Singular says causes the TPUs to satisfy the claimed error limitations. *See* Narayan Decl., Ex. 1 (Dr. Khatri Rpt.) ¶ 162 (Dr. Khatri conceding that BF16 multiplication in the MXU is performed “without further loss of precision”). So, no matter how Singular purports to rearrange those pairs, there can be no more than 256 rounding operations occurring simultaneously, which can at most equate to 128 *distinct* EUs because each EU, according to Singular, has two rounding circuits. *See id.* at Ex. 1 (Dr. Khatri Rpt.) ¶¶ 228–233. Thus, rather than confirming Singular’s theory, the number of simultaneously occurring rounding operations—which are stage one of the “two-stage operation” of both rounding and multiplying that Singular accuses, *see id.* at Ex. 1 (Dr. Khatri Rpt.) ¶ 223—actually undercuts it. There cannot be enough *distinct* LPHDR EUs to meet the “exceeds by at least one hundred” limitation under Singular’s theory.

Singular also claims that the composite sketch in Dr. Khatri’s report (which both parties use in their briefs to illustrate how Dr. Khatri’s infringement theory requires two rounding circuits for each LPHDR EU) “identifies the specific physical hardware” that makes up each accused LPHDR EU. Opp. at 3. But even Dr. Khatri would not back up that characterization: when asked at his deposition if the sketch [REDACTED]

[REDACTED] Narayan Decl., Ex. 4 at 279:2–280:12.

Moreover, repeatedly counting LPHDR EUs is not condoned by the specification of the asserted patents, as Singular suggests. *See* Opp. at 9. According to Singular, the specification explains that “in some embodiments, LPHDR execution units ‘share circuitry’ for the sake of efficiency,” *id.*, but that fundamentally mischaracterizes the specification. The specification’s discussion of “shar[ing] circuitry” on which Singular relies, refers to using the same circuitry for multiple functions *within a single LPHDR EU*, not counting the same circuitry 128 times as 128 different LPHDR EUs. The Court construed “execution unit” as a “processing element comprising an arithmetic circuit paired with a memory circuit.” Dkt. 354 at 25. Figure 4 in the specification, annotated below, shows an example “processing element” (PE). *See* Decl., Ex. C (’156 patent) at 10:38–40.

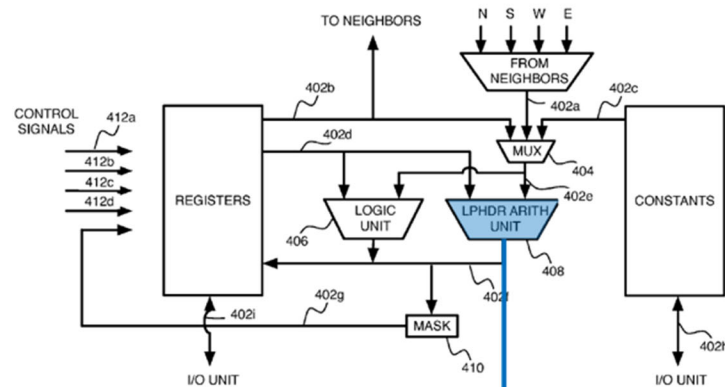


FIG. 4

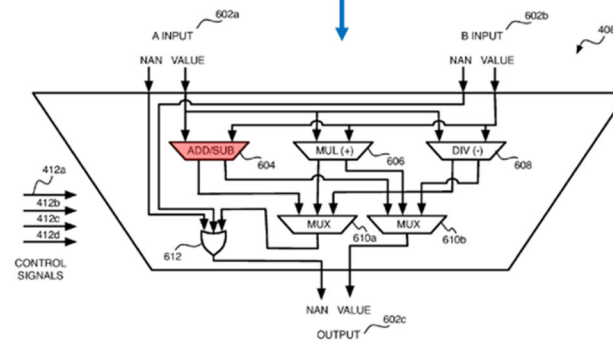


FIG. 6

Figure 6, in turn, shows in greater detail the “LPHDR arithmetic unit” labeled as **408** in Figure 4, including an “adder/subtractor” labeled as **604** that “performs LPHDR addition and subtraction.” *Id.* at 12:53–13:3. For that one sub-sub-component of an example PE, the specification explains that a “single combined adder/subtractor” is used because addition and subtraction are performed in “similar” ways and thus “share circuitry.” *Id.* at 13:42–46. More fully: “Often these two functions share circuitry, and this is why a single combined adder/subtractor 604 is used in the embodiment of FIG. 6.” *Id.* at 13:44–46 (emphasis added). Even if different sub-sub-components *within* an exemplary PE share circuitry, no shared circuitry is part of more than one EU. That solitary example of “share[d] circuitry” *within* a single PE does not grant license to double-count the same circuits 128 times as 128 *different* LPHDR EUs. To the contrary, the fact that Figure 6 shows the “combined adder/subtractor” as a *single unit* (rather than two distinct units) demonstrates that “shar[ing] circuitry” does not transform one thing into two.

Singular’s Opposition also spills much ink trying to justify its new infringement theory by criticizing the opinions and testimony of Google’s technical expert on non-infringement, Dr. Walker, claiming that Dr. Walker “did not provide any justification” for his opinions at his deposition and is purportedly “limit[ing] the claims based on a preferred embodiment.” Opp. at 8–9. Singular’s criticisms are irrelevant strawmen because Google’s Motion is based on Dr. Khatri’s infringement opinions, not on Dr. Walker’s non-infringement opinions. In fact, Singular acknowledges as much, admitting that Google “does not . . . cite Dr. Walker’s testimony” in its Motion. *Id.* at 8.<sup>5</sup>

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<sup>5</sup> Moreover, Singular has not challenged the relevance or reliability of Dr. Walker’s non-infringement opinions, so Singular’s criticisms amount to pure attorney argument.

Singular’s criticism of Dr. Leeser, one of Google’s invalidity experts, is likewise irrelevant. *See id.* at 9–10. In her prior art “VFLOAT system,” each LPHDR EU has distinct rounding and normalization circuits; none of that circuitry is shared between different LPHDR EUs. *See* Dkt. 494-1 (Leeser Rpt.) ¶¶ 102–109. The VFLOAT system thus invalidates the asserted claims in a different way than the accused TPU boards (purportedly) infringe under Singular’s “unique pairs” theory that repeatedly counts each rounding circuit in the accused TPU board 128 times. In any event, the issue of non-infringement properly turns on a comparison of the *claims* with the accused product, not on “similarities between the accused product and the prior art.” *01 Communique Lab., Inc. v. Citrix Sys., Inc.*, 889 F.3d 735, 744 (Fed. Cir. 2018).

**C. Google’s Motion Does Not Mischaracterize the Language of the Asserted Claims; Singular’s Argument to the Contrary Rests on Mischaracterizing Google’s Motion.**

Singular does not dispute that the Asserted Claims recite both “structural and functional limitations,” or that the numerosity requirement imposed by the “exceeds by at least one hundred” limitation is structural. *Opp.* at 13. As Google’s Motion explains, summary judgment of non-infringement is warranted when an accused product’s *operation* is used to show infringement of a *structural* limitation—as Singular has done with respect to the numerosity requirement. *See, e.g.*, *Mot.* at 12–13, 15–18; *Reckitt Benckiser LLC v. Aurobindo Pharma Ltd.*, 239 F. Supp. 3d 822, 828 (D. Del. 2017), *aff’d*, 737 F. App’x 537 (Fed. Cir. 2018).

Singular fails to address Google’s cited case law or identify any contrary authority, and instead resorts to misrepresenting Google’s position as denying that “the claim imposes any limitations relating to the ‘operations’ that must be performed by the claimed LPHDR execution units.” *Opp.* at 12. Not so. There can be no literal infringement “[i]f even one limitation is missing or not met as claimed,” *Mas-Hamilton Grp. v. LaGard, Inc.*, 156 F.3d 1206, 1211 (Fed. Cir. 1998), so Google’s Motion permissibly hones in on why and how the accused TPU boards

do not satisfy the “exceeds by at least one hundred” limitation. And in doing so, Google does not ignore the language of the claims, as Singular contends. Opp. at 13. The *Reckitt* court rejected an identical attempt to deflect the infringement analysis away from an undisputedly structural limitation and onto assertedly functional limitations that were not at issue: “The asserted claims recite structural limitations . . . as well as functional limitations . . . . The [expert] studies Reckitt relies on are relevant to determining whether Aurobindo’s [accused] proposed product meets the functional limitations. But those are not the limitations in dispute here . . . .” *Reckitt*, 239 F. Supp. 3d at 833. Regardless, Singular’s argument is additional proof that its infringement-by-clock-cycle theory is untenable because, notably, *nowhere* is “clock cycle” or operations per “clock cycle” recited in the Asserted Claims. The notion that infringement could turn on clock cycles is baseless.

### III. CONCLUSION

For the reasons explained in Google’s Motion and this Reply, summary judgment of non-infringement is warranted because the undisputed facts establish the accused TPU boards do not and cannot satisfy the Asserted Claims’ “exceeds by at least one hundred” limitation.

Respectfully submitted,

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/s/ Nathan R. Speed

Nathan R. Speed